Docket 2006.2

Textile Fabric For The Outer Shell Of A Firefighter's Garment

Field of the Invention

The present invention is directed to a textile fabric for use as the outer shell fabric of a firefighter's garment.

Background of the Invention

The outer shell fabric of a firefighter's garment must be flame, heat, abrasion, tear, and moisture resistant, durable, and lightweight. This outer shell fabric provides the first layer of protection for the firefighter.

U.S. Patent Nos. 5,095,549; 5,136,723; 5,701,606; 5,983,409; 5,996,122; and 6,038,700 disclose, among other things, firefighter's garments having an outer shell fabric made of PBI/aramid fibers.

U.S. Patent No. 5,299,602 discloses a woven, outer shell fabric made for firefighter's garments where the warp

yarns are multi-filament aramid yarns and the weft yarns are either multi-filament or spun aramid yarns.

U.S. Patent 5,628,065 discloses a firefighter's hood of a knit fabric formed of a blend of PBI and aramid fibers.

U.S. Patent Nos. 6,065,153 and 6,192,520 disclose a woven outer shell fabric for a firefighter's garments. This fabric has a plain, twill or rip stop weave and the yarns are a mixture of PBI and aramid fibers. The fabric has a weight ranging from 5.5 to 8 OSY, preferably, 7.5 OSY.

One popular outer shell fabric is a woven fabric of spun yarns consisting of PBI and aramid staple. This fabric is known in the market as 'PBI GOLD®.' In the U.S., this fabric generally is made in the following forms: 1) a 7.5 OSY rip stop weave made from a 16/2 c.c. spun yarns consisting of 40% by weight PBI and 60% by weight of a para-aramid; or 2) a nominal 7.0 OSY (actual 7.3 to 7.4 OSY) rip stop weave made from a 21/2 c.c. spun yarns consisting of 40% PBI and 60% of the para-aramid. Internationally, this fabric is in the form of a 6.0 to 6.5

OSY rip stop weave 24-25/2 c.c. spun yarns of 40% PBI and 60% para-aramid, or a twill weave made from 35/2 c.c. spun yarns of 40% PBI and 60% para-aramid.

Another fabric used as an outer shell fabric is marketed under the trade name 'Millenia' from Southern Mills, Inc. of Union City, GA. The Millenia fabric is made with a spun yarn consisting of 40% PBO and 60% para-aramid staple.

While 'PBI GOLD®' has proven to be an excellent outer shell fabric, there is still a need to improve these fabrics. There is a desire to have lighter weight fabrics that have better tear and abrasion resistance.

Summary of the Invention

The present invention is directed to a textile fabric. This fabric is preferably used as the outer shell fabric of a firefighter's garment. The fabric is a woven fabric of spun yarns and multi-filament yarns. The spun yarn includes a first staple being a polymer selected from the group consisting of PBI or PBO or melamine formaldehyde,

and a second staple being an aramid polymer. The multi-filament yarn includes an aramid filament.

Description of the Drawings

For the purpose of illustrating the invention, there is shown in the drawings a form of the invention; it being understood, however, that this invention is not limited to the precise arrangements and instrumentality shown.

Figure 1 is a plan view of the textile fabric made according to the present invention.

Figure 2 is a magnified plan view of the textile fabric made according to the present invention.

Description of the Invention

Referring to the drawings wherein like numerals indicate like elements there is shown in Figure 1 an illustration of the textile fabric 10 made according to the present invention. Preferably, the fabric 10 has a gold color with a 'checkered' pattern created by black multi-filament yarns 14. The fabric 10 is preferably woven with spun yarns 12 and multi-filament yarns 14. The weaves are

selected from the group consisting of plain, twill, rip stop, and oxford. The fabric weight may range from 6 to 8 OSY, preferably, 7 OSY. The weight ratio of spun yarns to multi-filament yarns should range from 85:15 to 92:8, preferably, 90:10. The multi-filament yarn may be inserted among the spun yarns, in both the warp and weft, at an insertion ratio of 1:5 to 1:20, preferably, 1:9. Preferably, the fabric is treated with a water/moisture resistant finish, as is well known.

The spun yarns 12 are a blend of a first staple and a second staple. The first staple is fiber made from a polymer selected from the group of PBI, PBO, a melamine formaldehyde, or combinations thereof. The second staple is a fiber made from an aramid or blends of aramids. Exemplary spun yarns include, but are not limited to, blends of PBI and aramid staple, PBO and aramid staple, melamine formaldehyde and aramid staples and PBI, PBO, melamine formaldehyde, and aramid staple. The spun yarns preferably comprise 45% by weight of the first staple, and 55% by weight of the aramid staple. The spun yarns may range in size from 32/2 to 16/2 c.c., preferably, 24/2 c.c.

PBI staple fibers are commercially available from Celanese Acetate LLC of Charlotte, NC. PBO staple fibers are commercially available under the trade name of ZYLON® from Toyobo Co., Ltd. of Osaka, Japan. Melamine formaldehyde fibers are commercially available under the trade name of BASOFIL® from BASF Corporation of Mount Olive, New Jersey.

The aramid staple fibers may be either a meta-aramid or a para-aramid; the para-aramid is preferred. Such aramid fibers are commercially available under the trade name of TWARON®, CONEX®, and TECHNORA® from Teijin Co. of Osaka, Japan; or NOMEX® or KELVAR® from DuPont of Wilmington, DE; or P84 from Lenzing AG of Lenzing, Austria; or KERMEL® from Rhodia Inc. of Cranbury, NJ.

The multi-filament yarn is made from aramid filament. Aramid may be either meta-aramid or para-aramid, the para-aramid is preferred. Such aramid fibers are commercially available under the trade name of TECHNORA®, TWARON®, and CONEX® from Teijin Co. of Osaka, Japan, or NOMEX® or KELVAR® from DuPont of Wilmington, DE, or P84 from Lenzing AG of Lenzing, Austria or KERMEL® from Rhodia Inc. of

Cranbury, NJ. The multi-filament yarn ranges in size from 200 to 1500 denier, preferably, 400 denier. The multi-filament yarn may be a flat yarn, a twisted yarn, or a stretch broken yarn.

The instant invention has superior tear and abrasion resistance, at a lower weight, over the PBI GOLD® fabric. The results are set forth in Table 1.

Fabric A is 6.0 OSY fabric; spun yarn is 27/2 c.c. with 45 percent weight PBI and 55 percent Technora® staple; multi-filament is a flat yarn inserted every 10^{th} yarn in the warp and weft.

Fabric B is 6.9 OSY fabric; spun yarn is 24/2 c.c. with 45 percent weight PBI and 55 percent Twaron® microdenier staple; multi-filament is a twisted yarn inserted every 9^{th} yarn in the warp and weft.

TABLE 1

Performance Characteristic	Test Method	PBI Gold	Invention A	Invention B
Weight (OSY)		7.5	6.0	6.8 - 7.0
Trap Tear (lbs.)	ASTM D5733 (Trapezoidal Method)	40 x 35	75 x 75	63 x 63
Tabor abrasion	ASTM D-3884 (500g wt. With H18 abrasion wheel)	225	180	293
Thermal Protective Performance, TPP (Composite)	NFPA 1971 (2000 Edition Section 6.10)	40	40	40
Trap Tear after UV	AATCC 16 E (Standard Method for Xenon arc exposure at 1.1 rad)			
60 hr		28.4 x 18.7	44.6 x 38.5	
180 hr		17.8 x 12.3	25.7 x 18.9	
300 hr		15.2 x 10.6	21.2 x 16.1	
Trap Tear after Sunlight	ASTM D5733 (Trapezoid Method)			
1 week		30.8 x 20.8	64.9 x 62.7	
2 week		24.3 x 17.0	45.5 x 40.1	
3 week		20.0 x 14.6	39.0 x 34.2	
4 week		18.8 x 13.1	34.0 x 33.9	
5 week		16.6 x 13.5	29.7 x 30.1	
6 week		14.8 x 10.5	26.6 x 23.6	

The present invention made be embodied in other forms without departing from the spirit and the central attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification, as indicated the scope of the invention.